

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2000-209510

(43)Date of publication of application : 28.07.2000

(51)Int.Cl. H04N 5/335

G02B 5/28

H04N 5/225

H04N 5/33

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(54) IMAGE PICKUP DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To obtain a small-sized image pickup device that copes with image pickup of both visual and infrared regions without the use of a changeover means for a filter such as insertion/removal of an infrared ray cut filter.

SOLUTION: The image pickup device is configured with an image forming optical system 1 on an optical axis A of an image pickup optical path, an optical low pass filter with an infrared ray cut coat 3 formed thereto, and a CCD(charge coupled device) 4 that applies photoelectric conversion to an incident light to obtain a picked-up image. In the case of photographing under visual light condition, while an infrared ray cut filter is

turned at a maximum angle (e.g. 45 degrees turning), a characteristic of transmitting visual rays and cutting infrared rays can be obtained, and the photographing under the usual visual rays is conducted. In the case of using this image pickup device for an infrared ray camera such as a night vision camera, the light up to the infrared ray region can be transmitted by decreasing the amount of turning.

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CLAIMS

[Claim(s)]

[Claim 1]It is an imaging device which has arranged respectively an infrared ray cut filter which consists of a visible light transmission board in which a multilayer film infrared cut coat was formed between an image formation optical system and an imaging device which were arranged in accordance with an optic axis, and an optical low pass filter, An imaging device which constituted said multilayer film infrared cut

coat so that the characteristic which penetrates visible light after a predetermined rotating range has carried out peak rotation from a field vertical to an optic axis, and intercepts infrared light might be obtained, and was constituted so that light of an infrared region might be made to penetrate as said rotation becomes small.

[Claim 2]It is an imaging device which has arranged a crystal optical low pass filter which formed a multilayer film infrared cut coat at a front face or the back between an image formation optical system and an imaging device which were arranged in accordance with an optic axis, From a field vertical to an optic axis, in 0 to 45 degrees, said crystal optical low pass filter presupposes that it is pivotable, and said multilayer film infrared cut coat, An imaging device which was constituted so that the characteristic which penetrates visible light and intercepts infrared light after said rotating range has carried out peak rotation might be obtained, and was constituted so that light of an infrared region might be made to penetrate as said rotation becomes small.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the imaging device which can be photoed in both a visible region and an infrared region.

[0002]

[Description of the Prior Art] The common video camera comprises a photographic subject side vertically on an optical axis in order of imaging devices, such as a coupling optical system, an infrared ray cut filter, an optical low pass filter, and CCD. In the photographic subject which has the sexual desire news near the picture element pitch of imaging devices, such as CCD, a false signal which is different from original video information in an imaging device might occur, and the moire phenomenon in which a color bleed in the outputted image might occur. An optical low pass filter is used in order to intercept and attenuate the spatial frequency component relevant to such an above-mentioned false signal.

[0003] By the way, imaging devices, such as CCD, have a comparatively large sensitivity characteristic, and, in addition to the light of a visible region, also answer the light of an infrared region in part. However, in the imaging device used for the usual photographic subject photography, it becomes the stray light, the fall of resolution, the silverfish of a picture, and nonuniformity arise, and infrared incident light has an adverse effect on color reproduction nature.

[0004] In order to eliminate such an adverse effect, the infrared ray cut filter is used, and colored glass was used conventionally in many cases. The multilayer film infrared cut coat (henceforth an infrared cut coat) which formed the dielectric of aluminum₂O₃, TiO₂, and SiO₂ grade in the multilayer in these days was used more often. An infrared cut coat is formed by vacuum evaporation or other means on the surface of an optical low pass filter, and this shortens the whole light path length by such composition, and part mark are reduced, and aiming at the miniaturization of an imaging device is also considered.

[0005] Practical use is presented with imaging devices, such as a video camera which can be picturized, also in near-infrared rays or an infrared region in recent years. This is what switches by inserting and detaching the infrared ray cut filter in an optical path, For example, in the imaging device, at the time of photography of a light range, infrared ray cut filters, such as colored glass, are inserted into an image pick-up optical path, and it has the composition of removing the infrared ray cut filter concerned from the optical path concerned at the time of photography of an infrared region (JP,52-125233,A). The composition which switches a visible light cut-off filter and an infrared ray cut filter is also devised (JP,61-13974,A). Image pick-up environment was switched by these composition.

[0006]however -- while, as for insertion-and-detachment **** of such an infrared ray cut filter, part mark of the change of a filter also increase -- the mechanism top -- large -- not becoming -- it did not obtain but there was a fault that light path length also became long.

[Problem(s) to be Solved by the Invention]It aims at obtaining the small imaging device corresponding to the image pick-up of visible light and both infrared fields, without having been made in order that this invention might solve the above-mentioned problem, and using the switching means of filters, such as insertion and detachment of an infrared ray cut filter.

[0007]

[Means for Solving the Problem]Paying attention to the operating characteristic of a multilayer film infrared cut coat being dependent on an incidence angle to the infrared cut coat concerned, this invention applies this to an imaging device visible light and both for infrared light, and is characterized by each of following composition.

[0008]Namely, between an image formation optical system and an imaging device which were arranged by claim 1 in accordance with an optic axis, Are an infrared ray cut filter which consists of a visible light transmission board in which a multilayer film infrared cut coat was formed, and an optical low pass filter an imaging device arranged respectively, and said multilayer film infrared cut coat, An imaging device constituted so that light of an infrared region might be made to penetrate is indicated as it constitutes so that the characteristic which penetrates visible light and intercepts infrared light after a predetermined rotating range has carried out peak rotation from a field vertical to an optic axis may be obtained, and said rotation becomes small.

[0009]Between an image formation optical system and an imaging device which were arranged in accordance with an optic axis by claim 2, It is an imaging device which has arranged an optical low pass filter which formed a multilayer film infrared cut coat in a front face or the back, From a field vertical to an optic axis, in 0 to 45 degrees, said optical low pass filter presupposes that it is pivotable, and said multilayer film infrared cut coat, An imaging device constituted so that light of an infrared region might be made to penetrate is shown as it constitutes so that the characteristic which penetrates visible light and intercepts infrared light after said rotating range has carried out peak rotation may be obtained, and said rotation becomes small.

[0010]It constitutes so that the characteristic which penetrates visible light and intercepts infrared light where peak rotation of the optical low pass filter in which a visible light transmission board or a multilayer film infrared cut coat in which a multilayer film infrared cut coat was formed was formed is carried out may be

obtained, and any composition picturizes ordinary visible light in this state. When using as infrared cameras, such as an infrared camera, infrared light is made to penetrate by making said rotation small.

[0011]The transmissivity characteristic (filter characteristics) of a multilayer film infrared cut coat is dependent on an incidence angle to the infrared cut coat concerned as mentioned above. Change of a transmissivity characteristic over a light incidence angle is shown in a graph using the sample A and the sample B below.

[0012]The sample A forms an infrared cut coat in one side of a quartz plate of one sheet. A thin film of TiO_2 and SiO_2 was formed repeatedly, and an infrared cut coat is 32 lamination on the whole, and at the time of zero light incidence angle, it is designed so that wavelength used as 50% of transmissivity may be set to 650 nm. As for drawing 6, in the sample A, drawing 8 of drawing 7 is [drawing 5] a graph for which drawing 9 shows change of a transmissivity characteristic over a light incidence angle, respectively in the time of the 55 degree at the time of the 45 degree at the time of the 35 degree at the time of the 20 degree at the time of zero light incidence angle.

[0013]The sample B forms an infrared cut coat in one side of a quartz plate of one sheet as well as the sample A. A thin film of TiO_2 and SiO_2 was formed repeatedly, and an infrared cut coat is 32 lamination on the whole, and at the time of 45 light incidence angles, it is designed so that wavelength used as 50% of transmissivity may be set to 650 nm. As for drawing 11, in the sample B, drawing 13 of drawing 12 is [drawing 10] a graph for which drawing 14 shows change of a transmissivity characteristic over a light incidence angle, respectively in the time of the 55 degree at the time of the 45 degree at the time of the 35 degree at the time of the 20 degree at the time of zero light incidence angle.

[0014]In both samples, it turns out that a transmissivity characteristic is moving all to the short wavelength side corresponding to an angle of rotation. Photography of a light range and an infrared light field can be performed using such the characteristic by making pivotable an infrared ray cut filter (infrared cut coat) to an optic axis.

[0015]That is, the transmissivity characteristic of an infrared ray cut filter (infrared cut coat) is beforehand set to the long wavelength (infrared rays) side, and it is used for an image pick-up to an infrared region as a night vision imaging device in this state. At the time of an image pick-up of only a light range, predetermined angle rotation is carried out, infrared light is intercepted, and it is used only in a light range.

[0016]In order to set the filter characteristics (beam-of-light transmission region) of an infrared ray cut filter (infrared cut coat) to the long wavelength (infrared rays) side, it is set as a value which did division of the class thickness with a predetermined value

to design wave length. Are general. Each thickness is set up in $1/8$ to $1/4$ of design wave length. That is, class thickness becomes thick when design wave length is set to the long wavelength side.

[0017]However, if an angle of rotation is too large, a wavelength area to which transmissivity is falling also in the wavelength range of a transmission region will appear. For example, in a graph of drawing 9 which made it rotate 55 degrees in both samples, and drawing 14, also in a transmission region, transmissivity of light of wavelength is falling in part, and image pick-up quality is reduced. A transmissivity characteristic with which practical use can be mostly presented in rotation up to 45 degrees also in which sample has been acquired.

[0018]If an infrared ray cut filter is rotated, a useful range of a filter will carry out narrowing. For example, when a filter useful range when not making it rotate is made into 100%, if it is made to rotate about 70% of useful range, and whenever [60] when it is made to rotate 45 degrees, it will be halved with 50% of useful range. It is about 70%, and if a minimum of a practical useful range becomes less than this, enlargement ***** of a filter leads to enlargement of an imaging device, and is not preferred.

[0019]It is necessary to determine material of a multilayer film, thickness, etc. that a transmissivity characteristic as shown in the sample B, in case a light incidence angle is the maximum (this example 45 degrees) will become good in a actual design.

[0020]The above-mentioned rolling mechanism may be manual [with a knob], and rotating operation may be carried out by a driving means by an actuator etc. An optical low pass filter may be based on a birefringence effect, and may be based on a diffraction grating.

[0021]

[Embodiment of the Invention]The embodiment by this invention is described with a drawing. Drawing 1 and drawing 2 are the mimetic diagrams showing an imaging device, and it is a mimetic diagram when drawing 1 extends the mimetic diagram at the time of a light range image pick-up and drawing 2 extends an imaging range to an infrared light field. Drawing 3 is a typical perspective view of the imaging device used by this invention, and is a figure explaining the rolling mechanism of the optical low pass filter in which the infrared cut coat 3 was formed.

[0022]Imaging devices are the optical low pass filter 2 in which the image formation optical system 1 and the infrared cut coat 3 were formed on the optic axis A of an image pick-up optical path, and the composition that CCD(charge coupled device) 4 which carries out photoelectric conversion of the incident light, and acquires an image pick-up image was arranged. The image formation optical system 1 comprises two or

more lenses. It consists of two or more quartz plates, the quartz plate with which the directions of light separating differ is combined so that a desired light separating pattern may be obtained as a whole, and the optical low pass filter 2 is stuck by adhesives etc. The two or more layers dielectric membrane of SiO₂, TiO₂, aluminum₂O₃, ZrO₂, or MgF₂ grade is put together suitably, and the infrared cut coat already kicked is constituted by the front face of an optical low pass filter.

[0023]In this embodiment, the combination layer of aluminum₂O₃, SiO₂, and TiO₂ is repeatedly formed by a vacuum deposition method, and forms a thickness of about 3 micrometers as a whole. A thickness of one layer each is about 0.1 micrometer, and it makes visible light penetrate very efficiently while reflecting only the light of an infrared region selectively by this using the interferential action of the light of a thin film.

[0024]The optical low pass filter 2 in which the infrared cut coat 3 was formed comprises a field where the entrance plane becomes vertical to an optic axis pivotable 0 to 45 degrees. Although this angle of rotation can also be set as the angle of rotation beyond it, when the upper infrared ray cut filter characteristic and the characteristic of an optical low pass filter are actually taken into consideration, a mentioned range is an effective range in practice, and 0 to 30 degrees is a more desirable range also from filter characteristics as above-mentioned.

[0025]In such an imaging device, in the image pick-up under a visible situation, it is in the state to which peak rotation (for example, 45-degree rotation) of the infrared ray cut filter was carried out, it constitutes so that the characteristic which penetrates visible light and intercepts infrared light may be obtained, and ordinary visible light is picturized in this state. When using as infrared cameras, such as an infrared camera, even an infrared light field is made to penetrate by making said rotation small.

[0026]As shown in drawing 3, an optical low pass filter may be installed in the rotating table 51, and it may be made to rotate with the external energy from drive mechanism, and a rolling mechanism forms a knob, and may enable it to adjust it manually. It cannot be overemphasized that the above-mentioned rotation may be rotation of an opposite direction.

[0027]Other embodiments by this invention are described with drawing 4. Drawing 4 is a mimetic diagram showing an imaging device, and has composition which provided individually the optical low pass filter and the infrared ray cut filter. The same component part as an above-mentioned embodiment is explained using a jack per line. An imaging device is the composition that the infrared ray cut filter 7 in which the image formation optical system 1 and the infrared cut coat 70 were formed on the

optic axis of an image pick-up optical path, the optical low pass filter 8, and CCD4 which carry out photoelectric conversion of the incident light, and acquire an image pick-up image were arranged. The image formation optical system 1 comprises two or more lenses. An infrared ray cut filter consists of the visible light transmission board 6 and the infrared cut coats 70, such as clear glass, and as an infrared cut coat, the two or more layers dielectric membrane of SiO₂ and TiO₂ is put together by turns, and it is constituted.

[0028]In this embodiment, an optical low pass filter and an infrared ray cut filter are provided individually, and since it is the composition of rotating only an infrared ray cut filter, it is not necessary to take into consideration change of the operating characteristic of the spatial frequency by rotating an optical low pass filter.

[0029]

[Effect of the Invention]According to this invention, it constitutes so that the characteristic which penetrates visible light and intercepts infrared light where peak rotation of the optical low pass filter in which the visible light transmission board or the multilayer film infrared cut coat in which the multilayer film infrared cut coat was formed was formed is carried out may be obtained, and ordinary visible light is picturized in this state. When using as infrared cameras, such as an infrared camera, infrared light is made to penetrate by making said rotation small. Therefore, the imaging device visible [which was miniaturized] and both for infrared can be obtained, without enlarging on structure, since it is not necessary to insert and detach an infrared ray cut filter like before.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]The mimetic diagram of the imaging device in which an embodiment of the invention is shown.

[Drawing 2]The mimetic diagram of the imaging device in which an embodiment of the invention is shown.

[Drawing 3]The typical perspective view of the imaging device in which an embodiment of the invention is shown.

[Drawing 4]The mimetic diagram of the imaging device in which other embodiments of this invention are shown.

[Drawing 5]The graph which shows the example of a transmissivity characteristic over an incidence angle

[Drawing 6]The graph which shows the example of a transmissivity characteristic over an incidence angle

[Drawing 7]The graph which shows the example of a transmissivity characteristic over an incidence angle

[Drawing 8]The graph which shows the example of a transmissivity characteristic over an incidence angle

[Drawing 9]The graph which shows the example of a transmissivity characteristic over an incidence angle

[Drawing 10]The graph which shows other examples of the transmissivity characteristic over an incidence angle

[Drawing 11]The graph which shows other examples of the transmissivity characteristic over an incidence angle

[Drawing 12]The graph which shows other examples of the transmissivity characteristic over an incidence angle

[Drawing 13]The graph which shows other examples of the transmissivity characteristic over an incidence angle

[Drawing 14]The graph which shows other examples of the transmissivity characteristic over an incidence angle

[Description of Notations]

1 Image formation optical system

2, 8 optical low pass filters

3, 70 infrared cut coats

4 CCD

6 Visible light transmission board

7 Infrared ray cut filter